§19. Hard X-ray Diagnostic System Intended to Study Effect of Bumpy Ripple Control on Plasma Confinement in Heliotron J

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In the Heliotron J device based on the quasi-ominigeneous concept, the bumpy ripples plays an important role in neoclassical confinement [1,2]. In order to explore optimized configuration from experimental approach, the Heliotron J is designed to be flexible in changing the magnetic field configuration. The purpose of this work is to investigate dependence of confinement property on magnetic field configuration through measuring pulse height spectra of X-rays ,i.e. energy distribution of electrons in low density ECRH plasmas.

Aiming at detection of X-rays originating from electrons, a hard X-ray detector based on a cadmium telluride (CdTe) diode (Amptek inc. /XR -100T- CdTe) is chosen because a silicon (Si) semiconductor detector suitable for measuring relatively low energy X-rays is being employed in the Heliotron J. Because of higher Z than that of the Si detector, the CdTe detector is favorable for high energy X-ray measurement. The thickness of beryllium (Be) window installed in front is 4mil. Figure 1 shows detection efficiency as a function of photon energy. This was calculated by use of the linear attenuation coefficients for Be given in Ref. 3. It is seen that the detector has uniform efficiency in the energy range from 7 keV to 50 keV. On the other hand, the Si detector used in Heliotron J significantly loses efficiency in energy range above 10 keV. Hence this detector can cover for the Si detector for high energy range. We need to know the relation between pulse height and photon energy before we use it. The detector was therefore exposed by radioactive γ-ray sources to perform energy calibration. Figure 2 shows pulse height spectra due to exposure of γ-rays from ^{133}Ba and ^{241}Am. The sharp peaks are so-called photo peaks which can be used for the calibration. From this figure, we confirmed that there exists linearity between the γ-ray's energy and pulse height from the detector. Also this figure gave us a conversion coefficient from pulse height in V to photon energy in keV.

Next, we installed this detector on CHS to find the aperture diameter suitable for actual use in Heliotron J because plasma parameter of Heliotron J is similar to that of CHS. Figure 3 shows X-ray energy distribution from CHS plasma in B_t of 0.95 T. The diameter of circular aperture is fixed to be 100μm and currently the aperture can not be changed from the outside of vacuum. The ECR wave of 53.2 GHz is perpendicularly injected in this case. In comparison with higher n_e case, total photon flux is larger and effective temperature looks higher in lower n_e case as expected. However, it is obvious that the aperture diameter of 100μm is too small to obtain good statistical photon counts in this case. In next fiscal year, we are going to improve the aperture system to make change of aperture size possible from the outside of vacuum and install this detector system on Heliotron J device.

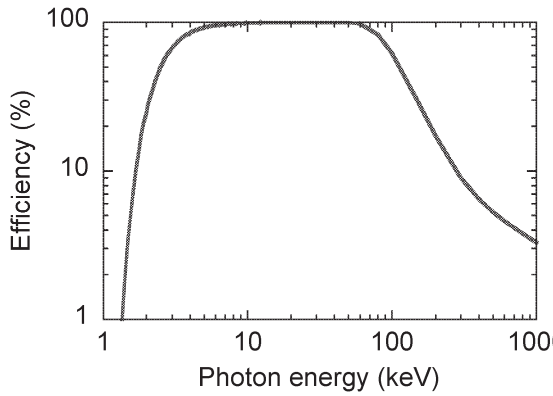

Fig. 1 Detection efficiency as a function of photon energy for the CdTe X-ray detector.

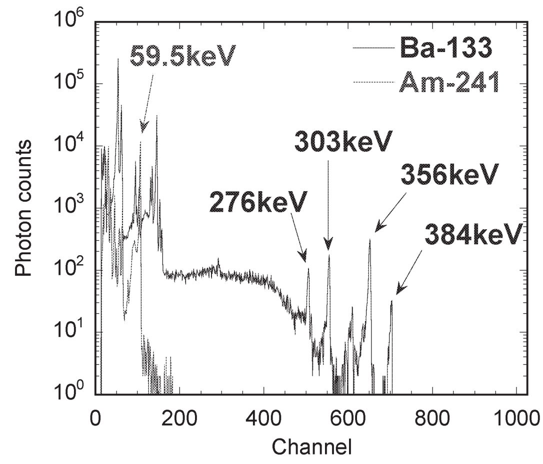

Fig. 2 Pulse height spectra due to γ-ray exposure.

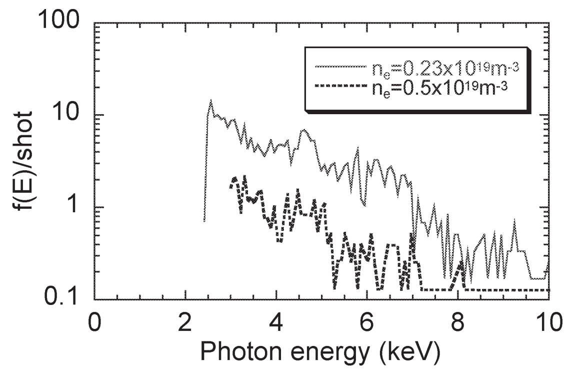

Fig. 3 Energy distribution of X-ray from ECRH plasmas of CHS in B_t of 0.95T.

References
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